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PRODUCTIVITY INDICATORS AND BEST MANAGEMENT PRACTICES SITUATION IN AQUACULTURE INDUSTRY IN NIGERIA

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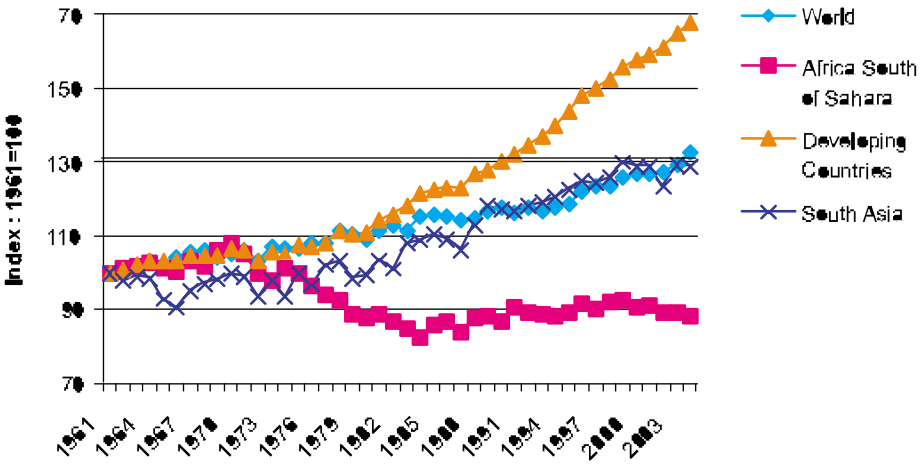
ABSTRACT

A study was conducted in February to March 2010 to analyzed constraints and identifies research priorities for development of aquaculture in Nigeria. It incorporated a cross-sectional analysis of participatory approach involving consultations with relevant stakeholders across the five agro-ecological zones of Nigeria. Consultations were made with Research Institutes and their training arms, the Fisheries Colleges; Universities, the Federal Department of Fisheries, Fish Farmers' Organizations (especially Catfish Farmers' Association of Nigeria, CAFAN), Agricultural Development Projects (ADPs), Non-Governmental Organizations (NGOs), Fisheries Society of Nigeria (FISON), National Special Programme on Food Security (NSPFS), Input Dealers, some private farmers and the private sector focused Catfish Farming Development Programme of the International Finance Corporation (IFC). Extensive review of relevant literatures related to aquaculture development in Nigeria and global perspective was carried out. A component of the study was to analyze the situation of the industry in terms of productivity levels and best management practices compared with global standard. Findings reveal that the best practice ethics is not yet in place in the industry. This results in poorly designed fish culture facilities, improper management, low fish survival rate in hatcheries and production ponds, resulting in low productivity and poor returns on investment. The major constraints to the growth of the industry include low quality of consultancy services, high cost of imported feeds and drugs, high cost and scarcity of fast growing fish seeds, lack of access to finance, prevalence of diseases and pests, poor quality of consulting services and absence of guidelines to regulate conduct of business in the industry along the production and supply value chain. Although the Nigerian aquaculture industry boast of the largest manpower (in that sub-sector) in Africa; the quality of business development services are considered low. Research Institutes and Universities have regular funding problems for aquaculture research, poor infrastructures, and lack of exposures of staff to regular trainings to enable them be at par with global expertise on aquaculture development.

INTRODUCTION

High and sustained rates of agricultural growth, largely driven by productivity growth, will be necessary if African countries are to accelerate poverty reduction. This is because agricultural growth has powerful leverage effects on the rest of the economy, especially in the early stages of development and economic transformation, when agriculture accounts for large shares of national income, employment, and foreign trade. This is the case in many African countries today (FARA, 2006).

The poor performance of the agricultural sector explains much of the slow progress towards reducing poverty and hunger in Africa. Agricultural growth has barely kept up with population growth rates such that the growth in per capita agricultural output has lagged far behind other developing regions (**Figure 1**). To reverse this trend and meet the Millennium Development Goal (MDG) of halving poverty by 2015, the sector needs to grow much faster and maintain annual growth rates of about 6.2 percent according to recent estimates. Some countries will require even higher growth rates, given the many years of neglect. Increasing agricultural productivity implies a transformation from traditional to modern agriculture, which "*involves both technical change and the presence of input, seasonal finance and marketing systems to increase farm production and deliver it to consumers at a competitive price*"



Source: FARA, 2006

Figure 1. Growth trends in per capita value-added output of agriculture.

(Poulton and Dorward, 2006).

At the production level, agricultural productivity measures the value of output for a given level of inputs. To increase agricultural productivity, the value of output must increase faster than the value of inputs. Gains in overall agricultural productivity can therefore come from changes in the physical productivity level through change in technology employed in the production process, which results in more output per unit of input such as land (yields) or labour, or from changes in production and market costs and hence the increased profitability of farmers. Thus, increasing agricultural productivity not only relies on improved production efficiencies, such as through adoption of modern or improved technologies and practices, but also critically relies on many other factors such as adequate access to productive resources, well functioning markets and infrastructure, and a conducive policy environment e.g., stable macro-economic policies (FARA, 2006).

Current Situation In Nigeria Aquaculture Industry

Nigeria currently has a relatively fast growing aquaculture industry. This industry has a great potential for growth because of the availability of key resources, including abundant water, land, labor, and markets. Presently, the

dominant cultured species are the siluroids (catfishes, about 85% of total production), the cichlids (tilapias), common carp and others (15%). The other candidates for aquaculture expansion include not less than 10 other freshwater species and 5 brackish water species. One major obstacle to achieving the potential of aquaculture growth in Nigeria is conditioning these species to intensive culturing, including methods for improving growth, reducing stress and disease, and controlling reproduction. Also needed are the development of improved aquaculture systems and the establishment of various production parameters for these species.

Aquaculture is becoming increasingly popular in Nigeria. A survey conducted in 2005 by IFC showed that a total of about 6000 hectares of land were devoted to aquaculture. Along agro-ecological zones, the distribution of operational farms were South east (20.8%), South west (50.8%), Central zone (12.1%), North east (8.8%) and North-West (7.5%). About 77% of the total land areas devoted to fish farming are in the hands of small-holders with pond sizes ranging from $25m^2$ to less than 1ha. Pond distribution by ownership shows that 89% were privately owned fish culture media in Nigeria include earthen ponds, outdoor concrete ponds (small scale or commercial) and the more intensive re-circulating indoor concrete and fiber glass tanks. Integrated poultry- fish culture is being practiced in some research stations.

The last decade (2000-2009) witnessed a new revolution in the Nigerian aquaculture industry. The innovation platform brought in fast growing fish species (especially the African Catfish), better formulated feeds that are very rich in nutrients, better expertise and service providers in the industry and subsequent annual increases in aquaculture productions. This era also witnessed a divestment of public institutions from fish farms that were not efficiently ran, the gradual dominance of the private sector in aquaculture development, and increased public awareness and interest in the industry.

Nigeria has great potentials for further growth of aquaculture despite her present ranking as the fifth largest producer in the world, the second in the continent of Africa and the largest in Sub-Saharan Africa. Proper utilization of available suitable land mass all over the country and the coast land for freshwater and brackish water finfish and shell fish culture could turn Nigeria from net importer to a net exporter and self sufficient in fish protein.

Indicators Of Productivity In Fisheries And Aquaculture

Ordinarily, productivity in fisheries is a measure of fish yield (weight per unit area, usually express in Kg/m^2 or tons/hectare). The fertility of an aquatic environment in terms of natural food density also indicates productivity of fisheries. Rogers *(*2007) classified indicators for sustainability of aquaculture into three groups:

1. Biological indicators – potentials for domestication, with genetic enhancement, trophic level; feed and energy conversion efficiency.
2. Ecological indicators – ecological foot print; emissions; escapees and feral population
3. Inter sectoral indicators – multiple water uses, diversity, cycling, stability and capacity.

In aquaculture research, a fourth dimension "**Economic Indicators of Productivity**" has not been considered until recently. No matter the standard of scientific indicators, there is a need to understand economic indicators which could be used to complement technical feasibility studies and thereby making economists relevant in project design and planning (Neiland, 1994). Economic objectives in aquaculture include efficient utilization of resources at the farmer's disposal (capital, labour and technology) and maximization of economic returns.

Biotechnical research in aquaculture aim at improving production possibilities under

the *best management practices* so as to maximize economic gains. Productivity per unit of water area from biotechnical point of view depends mainly on the stocking rate, survival rate and average weight of the individual fish at harvest. When this area combined with good management practices (correct stocking densities, right kind and amount of feeds, proper water quality, prevention of diseases and parasites, and elimination of predators) then high productivity can be assured.

Efficiency of different management systems or culture techniques such as extensive/intensive, mono culture/poly culture, mono sex culture/mixed sex culture, stagnant pond/flow through pond, integrated/non-integrated culture, demand standards for *best management practices* for of the systems in order compare productivity with the expected.

The Nigerian Aquaculture Productivity Situation

In the fast developing aquaculture industry in Nigeria, a lot of practices exist along the production – supply claim that are not standardized. Based on current practices and known *best practices* from other countries, the following are biotechnological indicators that can be used. Attempts are made to give quantitative estimates (in value terms) of the indicators (**Table 1**). For optimum utilization of the resources and increased production, productivity and returns to the farmer, improvement in the existing technology is necessary. Such improvements should aim at the following: i) improved farm design – for operational ease, ii) optimum soil and water condition, iii) removal of pests and predators, iv) qualitative and quantitative aspects for stocking fish seeds, v) supplementary feeding, vi) soil and water quality management, vii) monitoring of growth and health and vii) improved methods of harvesting and post-harvest management (value-addition).

Best Management Practices In Sustainable Aquaculture

Best management practice is the promotion of science-based management procedures to improve aquaculture productivity and profits through participatory approach. It involves facilitating innovation platform in service provision and interaction among stakeholders, capacity building and empowerment of primary producers, supporting improved food security, sustainable livelihood and promoting better market access for quality products.

Better Management Practice(s) (BMP(s) aimed at improving the quantity, safety and quality of products taking into consideration animal health and welfare, food safety, environmental and socio-economical sustainability. BMP implementation is generally voluntary. The term "better" is preferred rather than "best" because aquaculture practices are continuously improving (today's 'best' is tomorrow's 'norm') (FAO, 2005)

Best management practices (BMPs) in all spheres of agricultural production, processing and marketing are global issues aimed at making products economically, environmentally and socially sustainable and acceptable. According to NaCSA (2007) key issues in BMPs in aquaculture include legal compliance, land and water use ethics, hatchery, nursery and grow-out management; environmental management and social responsibility (**Table 2**).

Table 1. Nigerian Aquaculture Productivity Indicators

S/N	Catfish Productivity Indicators	Current Productivity /Situation	Best Management Practices	Least Expected Productivity
1.	Catfish stocking density			
	i. Extensive	● 10-15 fish/m^3	●30-40 fish/m^3	●30-40 fish/m^3
	ii. Semi - intensive	● 30 - 40 fish/m^3	●80 -100 fish/m^3	●60-80/m^3
	iii. Intensive	● 60-100 fish/m^3	●300-400/m^3(RAS)	●250-300/m^3
2.	Cropping frequency	● 1-2 times/yr	● 3-4 times /yr	● 3-4 times/yr
3.	Concrete tank lifespan	● 3 years	● 12-15 years	● 10-12 years
4.	Hatchery survival rate			
	i. Hatchlings/Fries	● 30%	● 90%	● 60%
	ii. Fingerlings/Juveniles	● 50%	● 90%	● 60%
5.	Grow-out pond survival rate	● 60%	● 90%	● 70%
6.	Table size (1kg) growth duration	● 8 months	● 3 months	● 4 months
7.	Table size(1kg) weight at 4 months	●500-800gm	● 1.5-2kg	●1-1.5kg
8.	Fish yield [monoculture]			
	iv. Extensive	● 40 tons/ha/yr	● 3000 tons/ha/yr	● 500 tons/ha/yr
	v. Semi – intensive	● 350 tons/ha/yr	● 20,000 tons/ha/yr	● 2,000 tons/ha/yr
	vi. Intensive	● 2,000 tons/ha/yr (200kg/m^2/yr)	● 100,000 tons/ha/yr	20,000 tons/ha/yr

Source: Field Survey, 2010

Table 2: Key Issues and Principles in Aquaculture Best Management Practices

ISSUE	PRINCIPLE
1. Legal compliance	Locate and operate farms within established national and local legal framework.
2. Land and water use	Farms should be located, designed and constructed to minimize negative impacts on other users and the environment.
3.Hatchery/Nursery/Grow-out Management	Adopt the best management options available in a sustainable manner, maximizing the profits while minimizing the risks of diseases and other related issues.
Environmental management	Minimize impacts on local environment and natural habitats
5.Social responsibility	Develop and operate farms in a socially responsible manner that contributes effectively to rural development and poverty alleviation.

Source: NaCSA (2007)

BMPs IN HATCHERY AND GROW-OUT PONDS.

Hatchery is the foundation in determining to a great extent the likely success or failure of a fish farm enterprise, while production or grow-out ponds are enterprise success outlets. For best results, both demand the highest level of operational norms. According to NaCSA (2007), the following are important considerations in aquaculture industry.

(i) Bio-security

This includes the issues of the hygiene and sanitation of the operators, the equipments/tools and the immediate environment (including assurance of water supply in quantity and quality).

(ii) Health management

Better management of seed, feed, facilities and this environment of culture prevent stress of stocks and consequently highly reduced or disease free environment.

(iii) Seed specification

This is an issue of supply of healthy seeds to fish farmers. Such seeds should survive standard stress test.

(iv) Feed and Feed management

Recommended feeds should be given to stocks in hatchery, nursery and grow-out ponds to avoid water pollution and consequent death. Remnant feed lead to deterioration of pond water quality.

(v) Use of drugs and chemicals

Some drugs and chemicals may be toxic to fish larvae or accumulate in their bodies and have some effects later in grow-out ponds. Improper application of chemicals may result in pollution of water and drug resistance build up in fish.

(vi) Traceability and record keeping

Traceability is the ability to follow the movement of a product of aquaculture through specified stage(s) of production, processing and distribution. The documentation and other evidence by which a certified product can be traced back from each buyer to each supplier through the chain of custody all the way to the certified production area from which it originated.

A systematic approach in record keeping can help ineffective monitoring. All records pertaining to fish farm operation should be maintained. The various procedures adopted right from sourcing of brood stock, sales of seeds and table size fish should be properly recorded.

(vii) Waste water management

Effluents and wastes from hatcheries and production ponds should be properly treated before discharge and farms should have necessary treatment facilities for treating the highest amount of waste water produced during the production period. Effluents discharged should be treated and meet stipulated standard without posing threat to the environment.

BMPS And The Nigerian Aquaculture Industry Situation

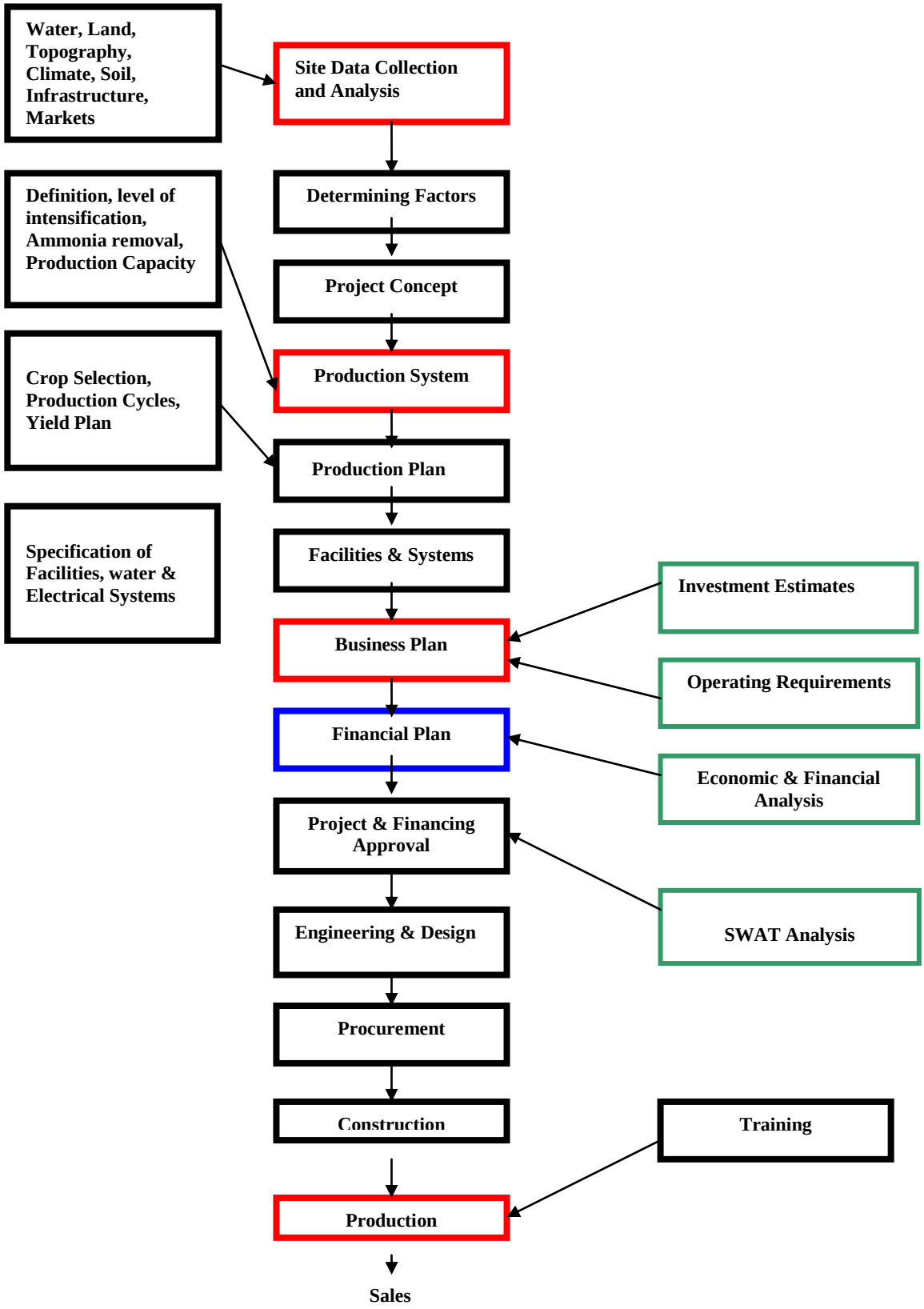
In the Nigerian situation, the aquaculture industry practices has been without industry policy standard guidelines on farm locations and operations, land and water uses, hatchery nursery and grow-out management, fish seeds certification, feeds production and importation standard, environmental management, consultancy competency assessment and post harvest product handling in conformity with global HACCP standards. As a result of this the following characterize the fish farming industry (**Table 3**). A typical best practice project business plan in the Nigerian catfish industry is shown in **Figure 2,** while the best management production practices from hatchery to grow-out ponds are shown in **Figure 3.**

Table 3. Comparison of Nigerian Aquaculture Situation with Best Management Practices

Nigerian Situation	***Best Practice Management***
1. Poorly designed and un-conducive rearing facilities resulting in management problems	*Management friendly enterprise with built to last structures and improved fish yield*
2. Sub-standard hatchery structures and unethical practices in fish seeds supply and consultancy	*Healthy and fast-growing fingerlings, with competent consultant backup*
3. Dominance of quacks posing as "consultants" in the industry	*Highly professional consultants as Service Providers*
4. Constant fish products price fluctuations putting farmers at the mercy of traders.	*Stabilized, predictable and favourable prices to farmers and marketers*
5.Threatening environment that cannot safeguard the sustainability of fish farming and consumers' safety.	*Conducive business environment that guarantee profitability of the aquaculture industry with healthy and high quality products*
6. High prevalence to diseases (>50%), especially in catfish farms	*Low prevalence of diseases (<20%)*
4. Poor fish yield	*High yield*
8. Poor flow of reliable, credible information to farmers	*Stakeholders' have stable mechanism for constant information sharing in the industry*
9. Poor know-how and adoption of BMPs	*Increased know- how and adoption of BMPs.*
10. Lack of coordination and cooperation among farmers leading to production losses	*Proper coordination and cooperation among farmers resulting in better management and business gains.*
11. High prevalence of discontinued production in a year cycle	*Guaranteed continuous production cycles yearly*
12. Poor farm products due to lack of industry standard	*High quality products with competitive pricing in local and international market.*

Source: Field Survey (2010)

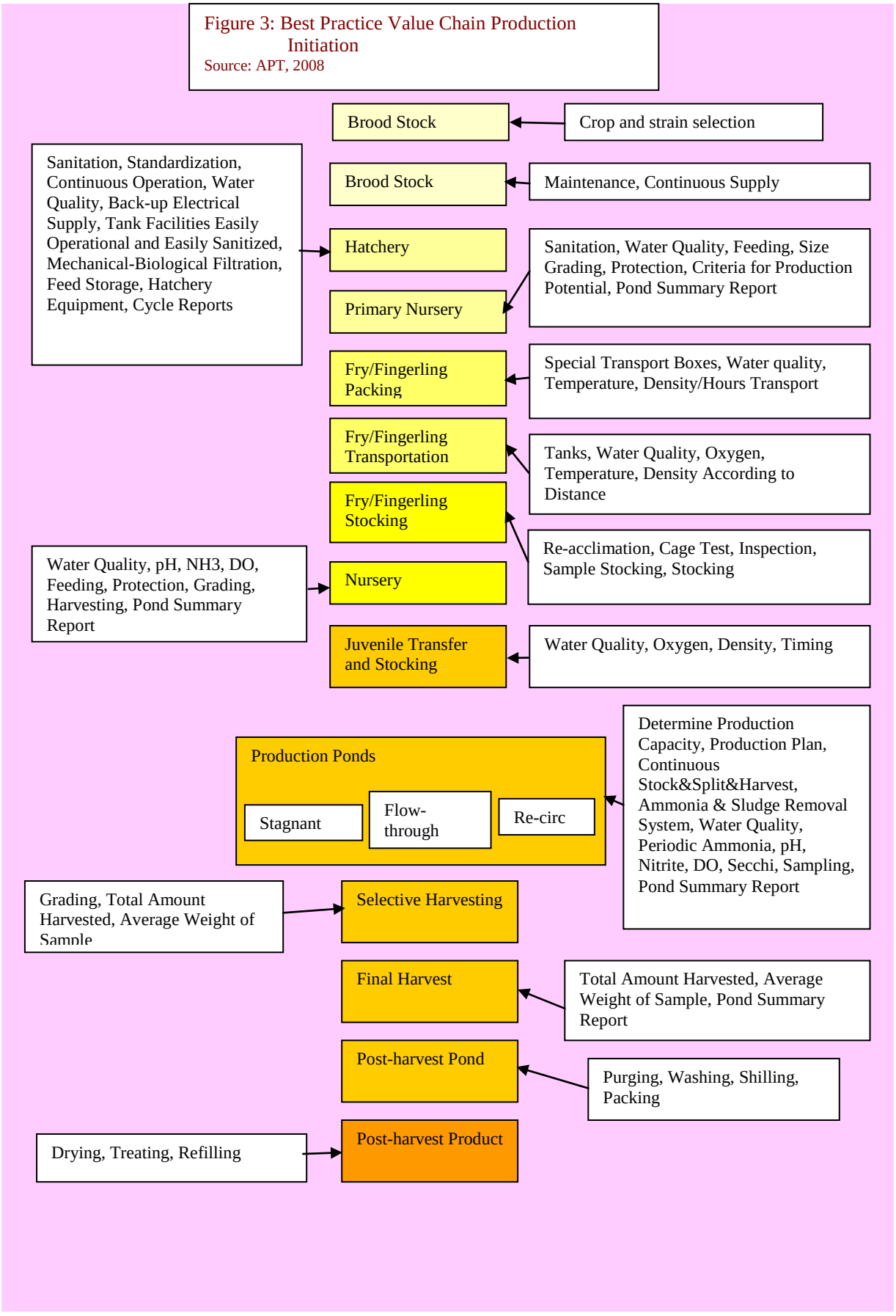
Figure 2. Best Practice Value Chain



Note – Some elements in the chain may not be applicable or will be adjusted for MICRO & SMALL projects

SOURCE: APT (2008)

Figure 3: Best Practice Value Chain Production Initiation
Source: APT, 2008



CONCLUSION AND RECCOMMENDATIONS

The current situation of the industry reveals that the *best practice* ethics is not yet in place. This results in poorly designed fish culture facilities, improper management, low fish survival rate in hatcheries and production ponds, resulting in low productivity and poor returns on investment.

The major constraints to the growth of the industry include low quality of consultancy services, high cost of imported feeds and drugs, high cost and scarcity of fast growing fish seeds, lack of access to finance, prevalence of diseases and pests, and absence of guidelines to regulate conduct of business in the industry along the production and supply value chain.

Although the Nigerian aquaculture industry boast of the largest manpower (in that sub-sector) in Africa; the quality of business development services are considered low. Research Institutes and Universities have regular funding problems for aquaculture research, poor infrastructures, and lack of exposures of staff to regular trainings to enable them to be at *par* with global expertise on aquaculture development.

On-shelf technologies are available in the research institutions, but these have been largely innovative research outcomes, not demand driven from the stakeholders' end. This is as a result of poor linkages between researchers and other stakeholders in the industry, especially the fish farmers. Some of these technologies when disseminated had very low adoption due to scarcity and high cost of adoption inputs and non-availability of technical back up. Lack of spelt out mechanisms for planning, prioritizing, implementation, monitoring and evaluation of demand-driven technologies by stakeholders are responsible for the situation.

The following are recommended to boost aquaculture productivity in line with best management practices:

1. The present dominance of the catfish in the industry is not a good development. Research should be encouraged on culture adaptability of about 15 indigenous fish species that have been proved to be culturable in fresh and brackish water environment in Nigeria. This will cause sporadic expansion in the growth of the aquaculture industry. More market opportunities will also be opened to give Nigerian fish products competitive advantage in global market.
2. There is need for multi-stakeholders' consultation with the objective of developing best management practices for aquaculture in Nigeria. Such include hatchery operators, grow-out farmers, processors, feed manufacturers/sellers, NGOs, academia, fisheries departments, professional bodies and farmers associations, etc. Specific *best practice* norms can be spelt out for species culture (including shrimps) and operating ethics on main issues related to aquaculture as well as principles to address such. A professional body like FISON can be empowered to exercise professional management's system control in order to regulate conduct of business in the industry.
3. There is the need to safeguard the sustainability of fish farming and consumers' safety, thereby maintaining quality and productivity.
4. Industry practices in aquaculture in Nigeria are not in consonance with global *best practice* trends. There is need for specific technical and business skill gap study, immediate and long term solutions or training programmes to address the gaps and ensuring measures to keep pace continuously with

improvement and practices in the industry.

5. Socially responsible aquaculture should be developed, operated and promoted to be the norms in the industry. Responsible aquaculture is that which benefits the farmers, the local communities and the country; contributes effectively to rural development, and particularly poverty alleviation; has employees who are treated fairly; ensures benefits are shared equitably; minimizes conflicts with local communities; ensures worker welfare and fair working conditions; minimizes risks to smallholders; and provides training to workers on responsible aquaculture practices.

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